

National Energy Technology Laboratory
Co-op Agreement No. DE-PS26-00NT 40898

Gasification Based Biomass Cofiring Project

**Integration of poultry litter gasification
with conventional PC fired power plant**

B. Patel – Nexant, Inc.; Kevin McQuigg – Primenergy LLC;
R. Tourney – WKE Inc.
NETL Project Manager Dr. Phil Goldberg

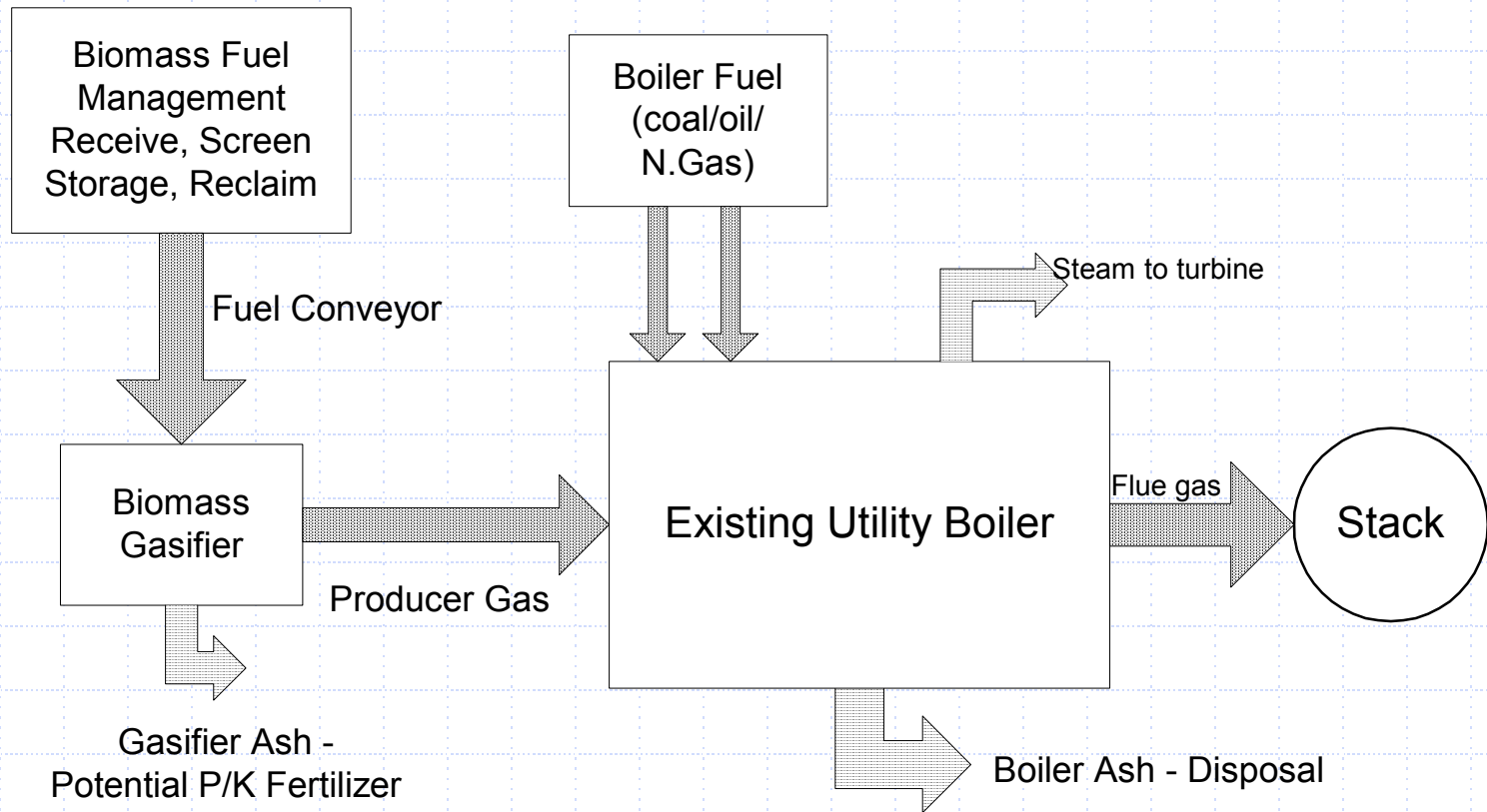
Participants

- ◆ US DOE NETL – program coordinator
- ◆ Nexant – overall engineering and cost estimate
- ◆ Primenergy – biomass gasification technology
- ◆ Western Kentucky Energy Corp – feasibility study site - Reid plant

Project Concept

- ◆ Cofire an existing pulverized coal fired boiler with low-Btu gas produced from poultry litter gasification
- ◆ Within 100 km of plant ~120,000 t/y of poultry liter available
- ◆ Energy production alternative to land application

Project Concept (contd.)



Project Issues

- ◆ Optimize gasifier size that can be integrated with existing boiler
- ◆ Verify performance and operating parameters of gasifier on poultry litter
- ◆ Minimize impact on existing boiler operation
- ◆ No additional emissions from gasification
- ◆ Cost benefits for the host utility

Project Phases

◆ Feasibility study

- Confirm fuel availability and characterization
- Evaluate integration of gasifier and boiler
- Determine optimum gasifier size
- Prepare preliminary design and plant layout
- Cost estimate and plant economics

Design Basis

◆ Pulverized coal-fired Boiler

- Fuel - Kentucky coal
- MCR 313,260 kg/h @ 90.63 bar, 514° C
(690,000 lbs/h steam @ 1,300 psig, 955° F)

As Burned Coal kJ/kg (Btu/lb)	Sulfur in Coal %	Air flow kg/h (lbs/h)	Excess Air %	Heat Release MMkJ (mmBtu/h)	Wind Box Pressure N/m2 (" of WC)	Furnace Pressure (N/m2) (" of WC)
27,447 (11,800)	2.5 Max	323,112 (711,700)	22	881 (835)	2366 (9.5)	1619 (6.5)

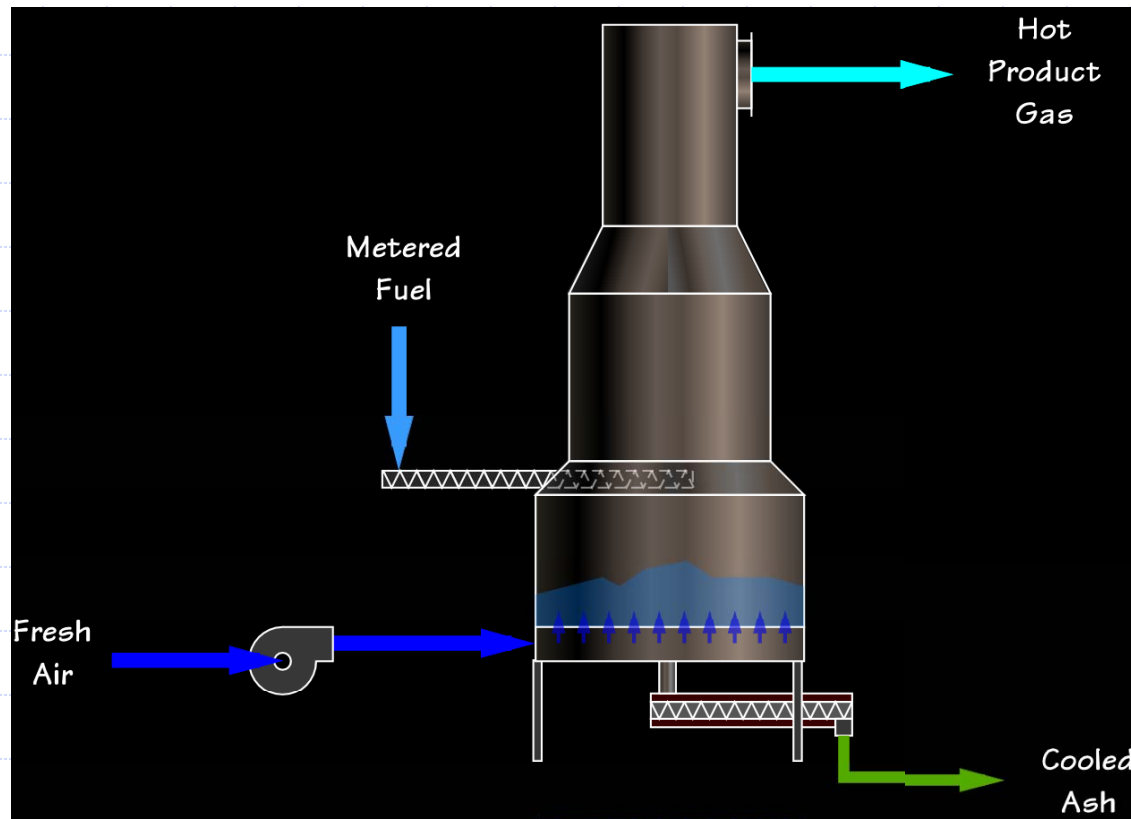
Design Basis (contd.)

◆ Gasifier Fuel – Poultry liter (droppings and biomass bedding)

■ Fuel Analysis

<u>Constituents</u>	<u>As Received</u>	<u>Dry Basis</u>
Moisture %	25~30	0
Fixed Carbon %	7~15	9~20
Volatiles %	35~45	50~67
Ash %	20~30	25~35
Sulfur %	0.4~0.7	0.5~0.9
Chlorine %	0.6~1.0	1.2~1.5
LHV kJ/kg (Btu/lb)	8,839-12,095 (3,800-5,200)	10,467-15,119 (4,500~6,500)

Design Basis (contd.)



◆ Gasifier
Primenergy
KC-18, air
blown, fixed-
bed, updraft
counter flow

Design Basis (contd.)

- ◆ Gasifier Capacity – 7.5 TPH of Litter
- ◆ Product gas – nominally 3,730 kJ/m³ @ 840°C (100 Btu/cu ft, @ 1400-1600°F)
- ◆ Total heat input from gasifier into the boiler 6-9% at MCR (50~75 MMBtu/h)
- ◆ Reduction in coal input with gasifier estimated at - 2,000-2,900 kg/h (2.2 ~ 3.2 TPH)

Tasks Completed

- ◆ Established site specific and boiler operating data
- ◆ Developed expected gasifier operation and gas composition
- ◆ Preliminary boiler analysis, location and design of boiler penetration
- ◆ Confirmed fuel supply & fuel sample analysis

Tasks Completed (contd.)

- ◆ Completed fuel characterization
 - Proximate and ultimate analysis
 - Slagging characteristics
 - Sizing
- ◆ Preliminary designs for fuel handling, gasification, & boiler modifications
- ◆ Estimates of emission levels from cofiring

Material & Energy Balance

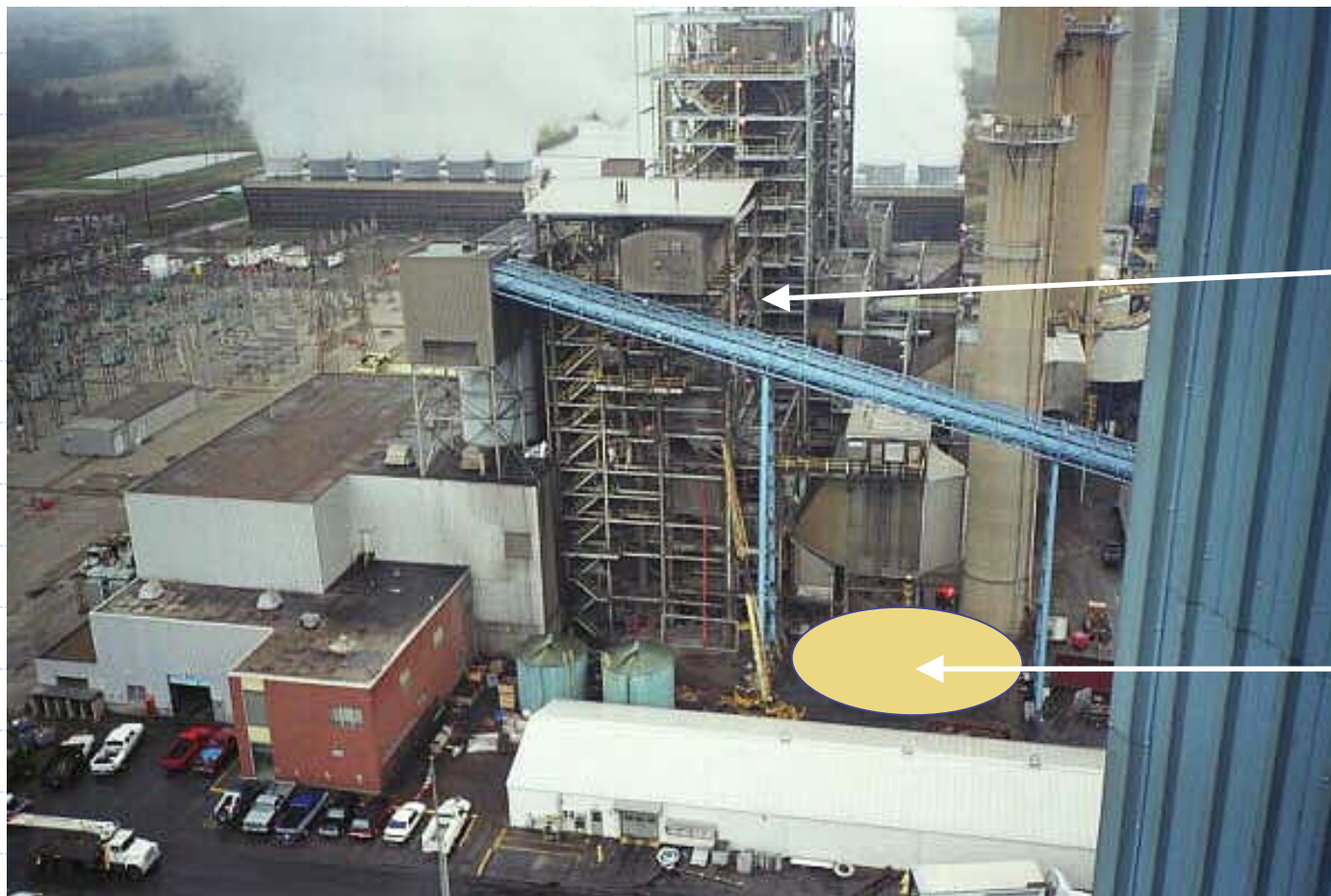
◆ Poultry Litter	8.2 t/h	7,394 kg/h
◆ Heating Value (LHV)	4,200 Btu/lb	9,769 kJ/kg
◆ Natural Gas (NG)*	46 lbs/h	21 kg/h
◆ Heating Value (LHV)	21,502 Btu/lb	50,014 kJ/kg
◆ Ash Produced	2.16 t/h	1,960 kg/h
◆ Heat Input from Gasifier	56.8 MMBtu/h	60x10 ⁶ kJ/h
◆ Boiler Rating @ Design	834 MMBtu/h	880x10 ⁶ kJ/h
◆ % Input from Gasifier	6.8 %	
◆ Boiler Efficiency	86.9 %	
◆ Gasifier Efficiency	81.8 %	

* Natural Gas for staged combustion of gases in reducing atmosphere.

Material & Energy Balance (contd.)

◆ Turbine Output (design)	65,851 kWe	
◆ Turbine Heat Rate	8,863 Btu/kWe	9,350 kJ/kW
◆ Output Due to Gasifier	4,484 kWe	
◆ Less Aux Load for Gasifier	410 kWe	
◆ Net Gasifier Output	4,075 kWe	
◆ Boiler Capacity Factor	70 %/year	
◆ Gasifier Capacity Factor	90 %/year	
◆ Total Poultry Litter Usage	44,984 tpy	40,809,485 kg/y
◆ Total NG Usage	253,865 lbs/y	115,153 kg/y
◆ Total Ash Produced	11,910 tpy	10,804,752 kg/y
◆ Total Power Produced from the Gasifier	22,486,260 kWh / year	

Proposed Gasifier Location



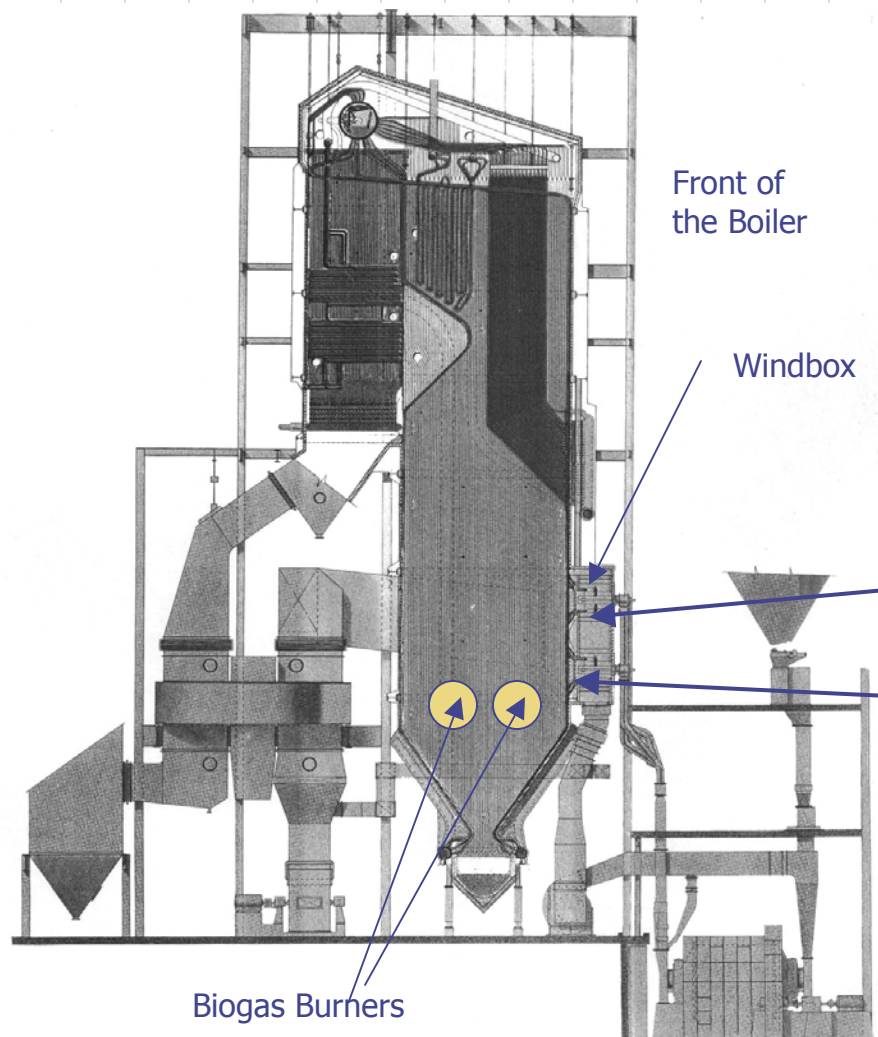
**Reid
Plant
Boiler**

**Gasifier
Island**

Fuel Receiving and Storage



Boiler Penetrations



- **Four Penetrations**

- **2 on each side of the boiler**

- **Just below the lower windbox line**

- **Pressure at the burner –10"-12" of WC**

- **Velocity at the burner 150~300 ft/sec**

- **Flow 70,000~100,000 scfm**

Biogas Burners
(2 on each side – 4 total)

Conclusions

◆ Potential Project Benefits

- Environmentally more acceptable renewable and premium power
- Reduced landfill and runoff into waterways
- Potential for reduced fuel cost
- Potential for fertilizer from ash (P/K)
- Gasification external to the boiler offers flexibility in biomass fuels